Energy Audit Summary Report

AEE INTEC

Audit no. 04 – AUT04

Metal Treatment

15th of June 2011

Supported by INTELLIGENT ENERGY EUROPE

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AUDIT no. 04 – AUT04

1. Data of the auditor

1.1. Contact data of the auditor

Name: Juergen Fluch
Organisation: AEE INTEC
Country: Austria
Profession: engineer
Number of audits performed: 1
Date of the audit: 15/06/2011
Duration of the audit: 4 weeks

2. Introduction

2.1. Objectives

The objectives of the audit are the modelling of the present state, the calculation of the energy consumption (total and process split) and furthermore the recognition of heat recovery potentials and possible changes in the energy supply. The production site consists of several production lines, buildings and offices. In accordance with the company the focus is set on the cathodic painting (KTL) and paint coating (DL), the most energy consuming part of the company.

3. Status Quo: processes, distribution, energy supply

3.1. General info of company

Sector: metal treatment in Austria
Number of employees: 250
Product: metal parts for cranes

3.2. Flow sheet of the whole manufacturing side (processes, distribution, energy supply) in form of a block diagram

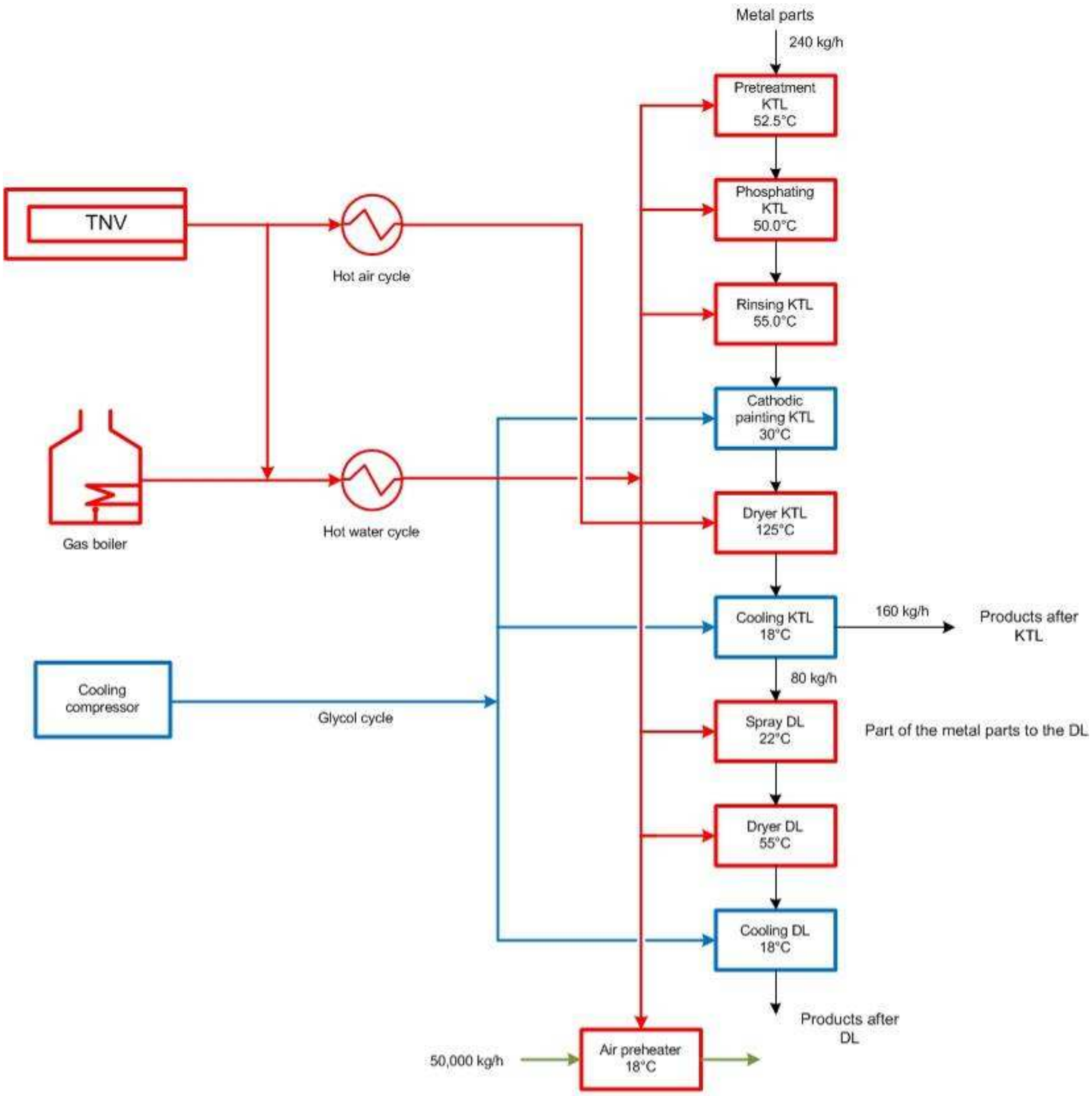

Figure 1: Flow sheet of the processes cathodic painting and paint coating including the most important temperatures of the processes as well as the generation of heat and cold and the distribution system
Explanation: TNV…thermal post-combustion, KTL…cathodic painting, DL…paint coating

3.3. Description of the existing system

In total the company produces about 1,000 tons of steel tubes per year. In the considered production line the steel tubes are cathodic painted (see Figure 1). Therefore, the metal parts are pre-treated at different temperatures, then painted and afterwards dried and cooled. About one third of the tubes is then additionally brought to the paint coating line where they are sprayed, dried and cooled. The cathodic painting and the two cooling processes (DL and KTL) have a cooling demand, while all other processes have a heating demand including the preheating of the air used in the cooling process.

The cold is supplied to the processes by a glycol network connected to a cooling compressor. For the heat two distribution lines are installed, a hot air cycle and a hot water cycle. The hot air cycle is connected to a heat exchanger supplied by the thermal post-combustion. Furthermore, the thermal post-combustion is connected to the hot water cycle via a heat exchanger. The hot water cycle can be reheated by a gas boiler.

The fuel used for this production line is mainly gas for the thermal post-combustion and natural gas for the gas boiler as well as electricity for the cooling compressor. The gas used for the thermal post-combustion is a "waste product" of several processes in the company and has therefore zero costs.

The evaluation of the present state can be seen in the following tables (Table 1 to Table 4) and figures (Figure 2 to Figure 11). The results of the EINSTEIN calculation match to the real state of the production line that could be well split based on the data made available by the company.

Table 1: Primary energy consumption (PEC) and primary energy consumption for thermal use (PET) – present state

Energy type (fuels / electricity)	PEC		PET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Total fuels	7.861	95,25	7.848	95,25
Total electricity	392	4,75	392	4,75
Total (fuels + electricity)	**8.253**	**100,00**	**8.240**	**100,00**

Figure 2: Primary energy consumption (PEC) – present state

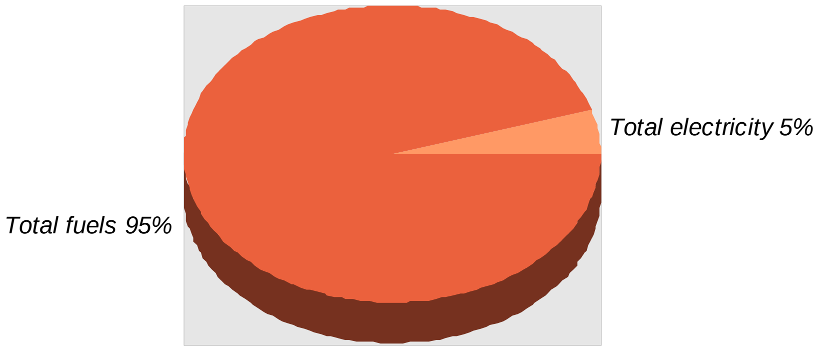

Table 2: Total final energy consumption (FEC) and final energy for thermal use (FET) – present state

Fuel type	FEC		FET	
	[MWh]	[% of Total]	[MWh]	[% of Total]
Natural gas	404	5,56	403	5,55
TNV	6.742	92,61	6.731	92,62
Electricity	133	1,83	133	1,83
Total	7.279	100,00	7.268	100,00

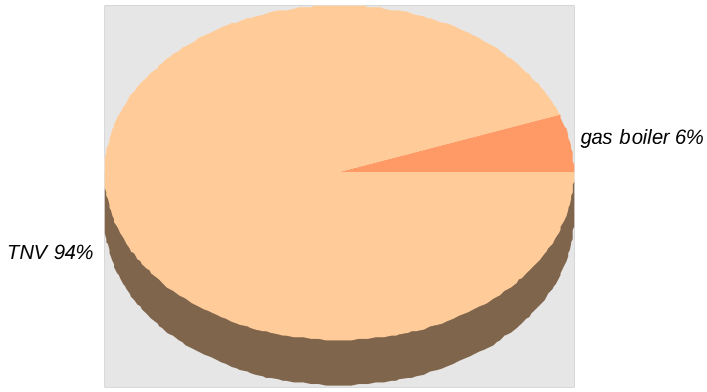

Figure 3: Useful supply heat (USH) by equipment - present state

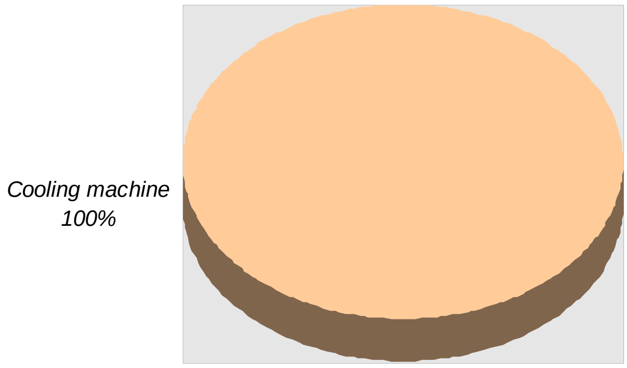

Figure 4: Useful supply cooling (USC) by equipment - present state

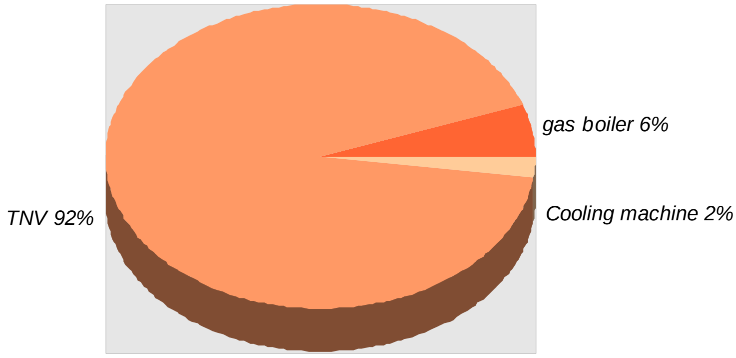

Figure 5: Final energy consumption for thermal use (FET) by equipment – present state

Table 3: Useful process heat demand (UPH) by process - present state

Process	Total [MWh]	Circulation [MWh]	Maintenance [MWh]	Start-up [MWh]
pretreatment_KTL	315	6	158	151
phosphating_KTL	119	0	62	57
rinsing_KTL	114	1	0	113
dryer_KTL	1.299	174	1.123	1
spray_DL	57	57	0	0
dryer_DL	419	45	374	0
cooling_KTL_heat	399	399	0	0
cooling_DL_heat	266	266	0	0
Total	**2.989**			

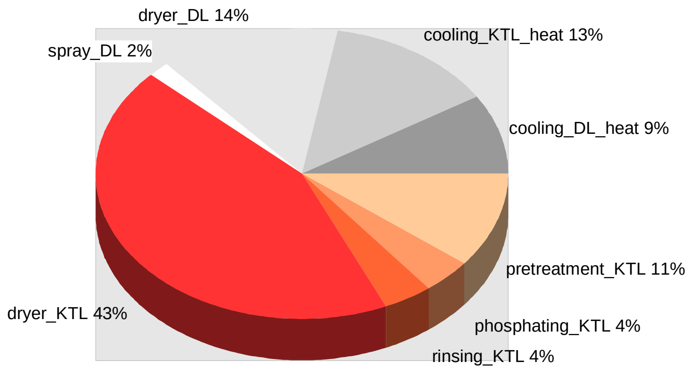

Figure 6: Useful process heat demand (UPH) by process - present state

Table 4: Useful process cooling demand (UPC) by process - present state

Process	Total [MWh]	Circulation [MWh]	Maintenance [MWh]	Start-up [MWh]
cathodic_painting_KTL	293	1	291	0
cooling_KTL	14	14	0	0
cooling_DL	2	2	0	0
Total	**308**			

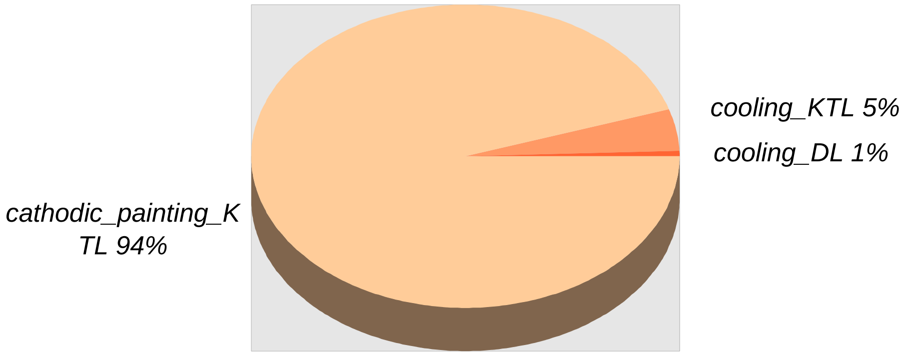

Figure 7: Useful process cooling demand (UPC) by process - present state

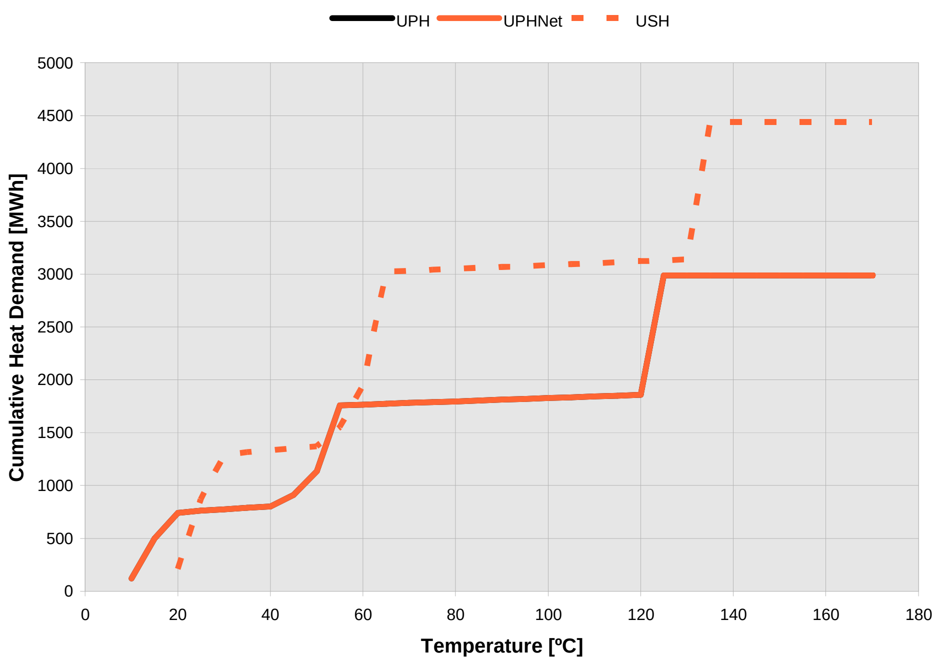

Figure 8: Distribution of the heat demand by temperature levels

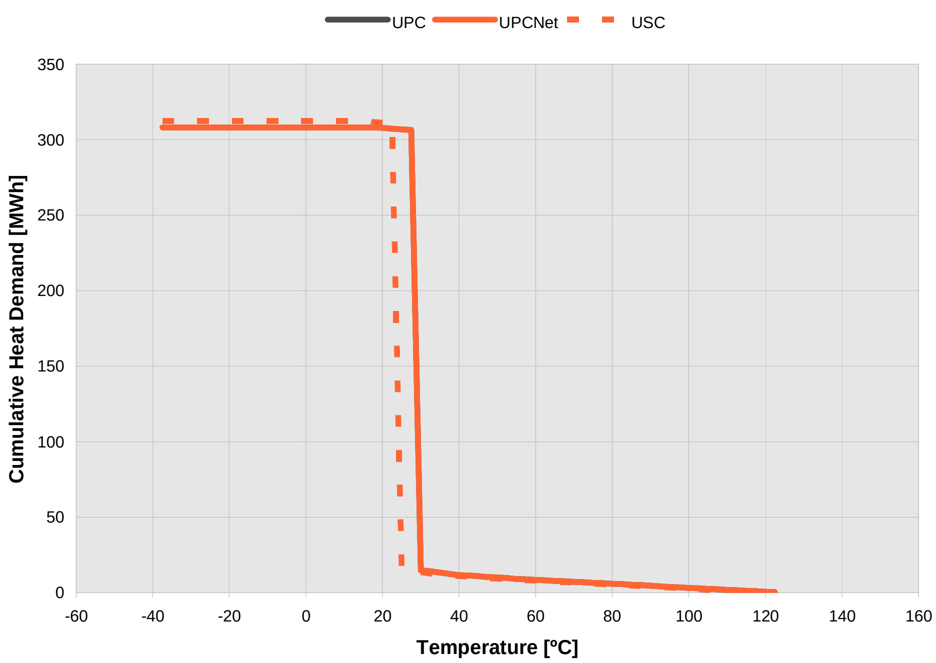

Figure 9: Distribution of the cooling demand by temperature levels

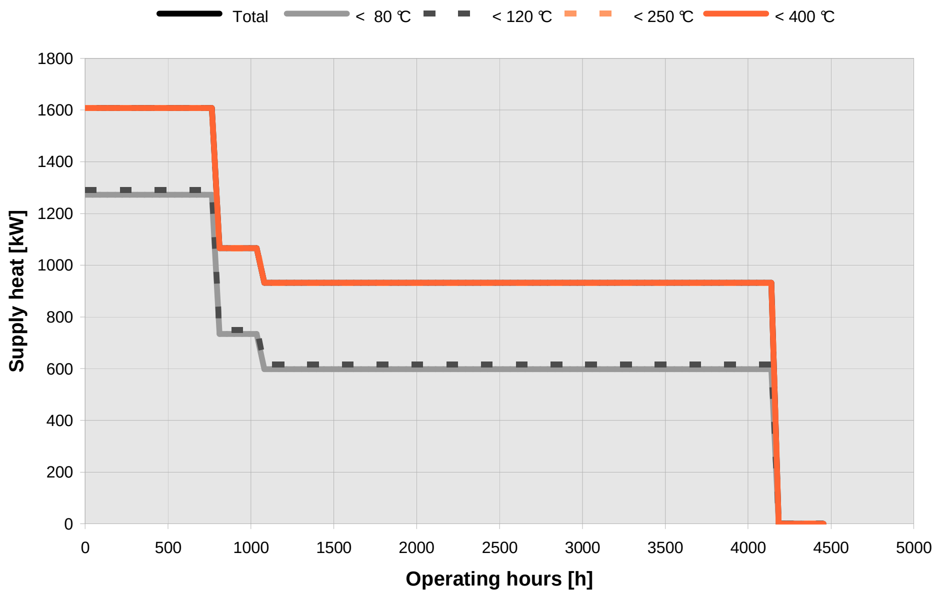

Figure 10: Distribution of supply heat by temperature levels and annual operating hours - present state

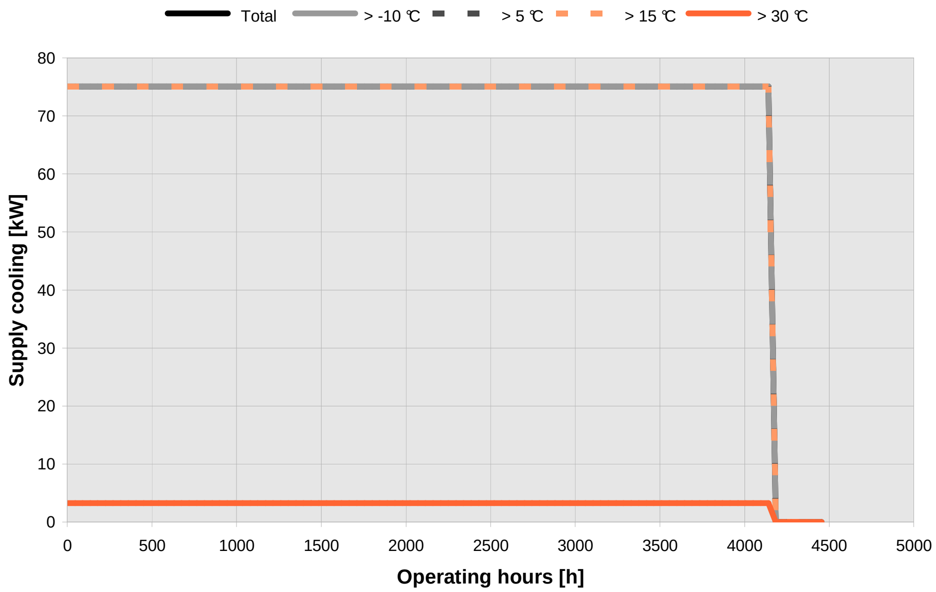

Figure 11: Distribution of supply cooling by temperature levels and annual operating hours - present state

3.4. General

As already mentioned, the steel tubes run through several pre-treatment processes before they come to the cathodic painting process. Some of the tubes (about one third) are then brought to the paint coating on a second floor of the production hall. For the calculation of the energy balance as well as the mass balance a 2 shift operation was assumed on the information of the company including 3 weeks of holidays in August. Based on the recordings of the company an hourly calculation of the energy demand of the processes was performed. The split of the energy demand on the processes was based on data of measurements of the energy demand of some pre-treatment processes as well as some estimation that had to be done in accordance with the operators in the company. These are mainly related to the heating demand of one pre-treatment process, the DL dryer as well as the start-up demand after weekend and night breaks. For the supply with fresh air an average ambient temperature (METEONORM data) was assumed.

4. Comparative study

4.1. Proposed alternatives

Table 5: Proposed alternatives

Explanations: HR…heat recovery, CHP…combined heat and power equipment

Short Name	Description	New equipments
HR	heat recovery network	2 heat exchangers (P1 = 64kW, P2 = 37kW)
solar	heat recovery network and solar thermal equipments for energy supply	2 heat exchangers (P1 = 64kW, P2 = 37kW) solar thermal flat plate P = 500kW
CHP	heat recovery network and CHP for energy supply	2 heat exchangers (P1 = 64kW, P2 = 37kW) CHP P = 938 kW

3 alternatives have been proposed. The first one is a heat exchanger network including 2 heat exchangers (preheating the air in the dryer_KTL by the waste air / preheating the air in the cooling DL by the waste heat of the cathodic painting). This heat exchanger network is also part of the other 2 alternatives. Additionally in the second proposal a flat plate collector with an installed capacity of 500 kW and a storage of 25 m³ is installed, while in the third alternative a CHP (natural gas turbine) with a nominal capacity of 938 kW is added to the energy supplying system.

5. Selected alternative(s) and conclusions

5.1. Selected alternative

Based on a discussion with the company owner the second alternative "solar" is selected as best solution. 2 heat exchangers should be installed with a total heat capacity of about 101 kW decreasing the primary energy demand by using the waste heat of the processes. Additionally a flat plate collector with a capacity of 500 kW is suggested. This way the maximum available surface of 2,000 m² is optimally used considering the costs for the collectors.

5.1.1. Process optimisation (written proposals)

Based on the available data and measurements performed no process optimisation was proposed.

5.1.2. Heat recovery

Table 6: Suggested heat exchangers

Heat Exchanger	Power	Heat Source	Heat Sink	Amount of recovered energy	
	[kW]			[MWh]	[%]
HX_AbovePinch_0	64	cathodic_painting_KTL 30.1℃ --> 30℃	cooling_DL_heat 8.4℃ --> 18℃	266	63,24
HX_AbovePinch_2	37	dryer_KTL 125℃ --> 13.4℃	dryer_KTL 8.4℃ --> 120℃	155	36,76

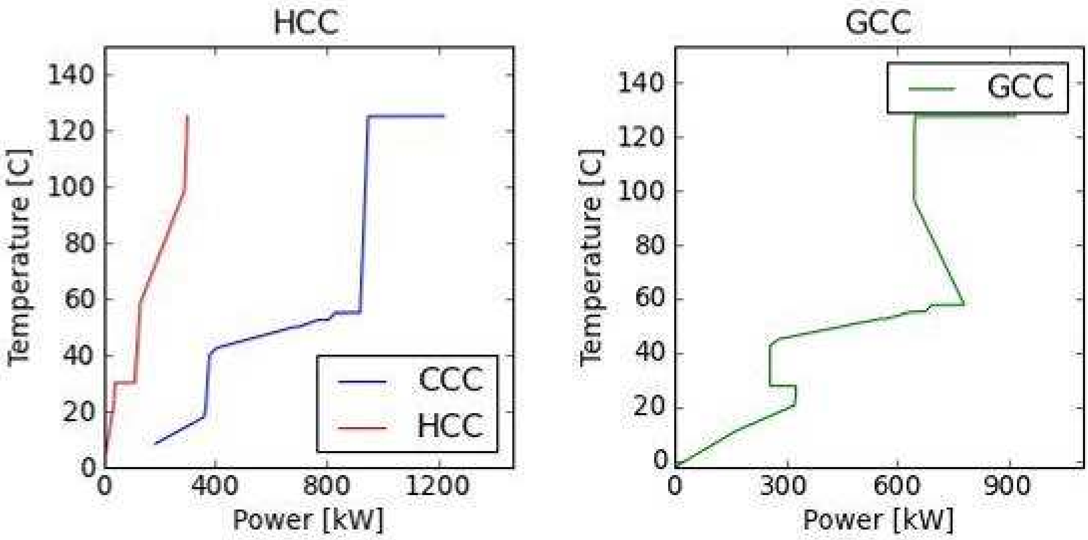

Figure 12: HCC / GCC curves heat exchanger network

By installing the heat exchanger network the primary energy consumption can be reduced by 17.5 %, the remaining heating demand is 3,681 MWh.

5.1.3. Heat and Cold Supply

collector type:	ETC (evacuated tube collector)
installed capacity:	500 kW
solar buffer storage volume:	25 m³
solar fraction:	10.66 %
annual energy yield:	609 kWh/kWa

The solar thermal collectors contribute 8.92 % to the total annual heat supply and therefore reduce the primary energy consumption of natural gas and electricity.

5.2. Comparative study and conclusions

Table 7: Comparative study

		Present state	**Alternative**	**Saving**
Total primary energy consumption (1)	*[MWh]*	*8,252*	*6,264*	*1,988*
Allocation of energy consumption	*[-]*			
Total fuels	*[MWh]*	*7,861*	*6,197*	*1,664*
Total electricity	*[MWh]*	*391*	*67*	*324*
Share of renewable energy	*[%]*	*0*	*7.9*	
CO_2 emissions	*[tons/a]*	*1,858*	*1,420*	*438*
Annual energy system cost (2)	*[MWh]*	*23,468*	*5,695*	*17,773*
Total investment costs	*[EUR]*		*630,000*	
Payback period (3)	*[years]*		*19.4*	

(1) including primary energy consumption for non-thermal uses

(2) including energy cost (fuel and electricity bills), operation and maintenance costs and annuity of total investment.

(3) Supposing 30% of funding of total investment (subsidies or equivalent other support mechanisms)

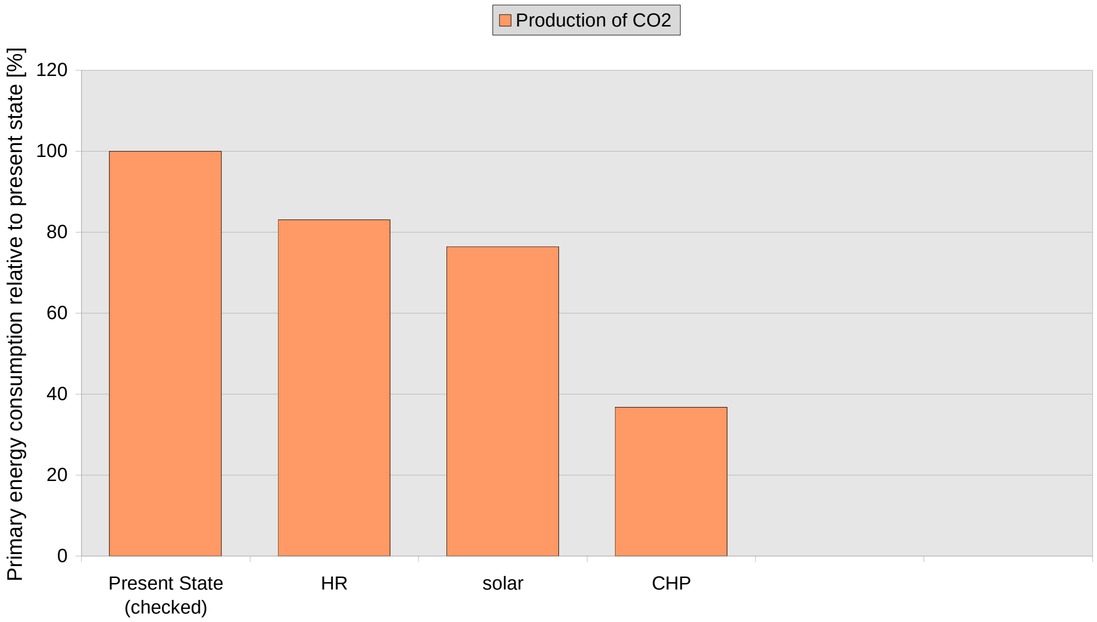

Figure 13: production of CO2 for present state and all proposed alternatives

5.2.1. Energy and environmental analysis

By installing the heat exchanger network the final energy demand for thermal use can be reduced. Additionally the solar thermal collectors partly replace the primary energy consumption via natural gas and electricity by a renewable energy.

5.2.2. Economic analysis

The investment costs for the heat exchanger network are assumed by € 10,000 and the flat plate collectors by € 620,000. The calculated payback period is therefore 19.4 years based on a funding rate of 30 %.

5.2.3. Conclusions and outlook

Based on the available data and measurements performed the energy consumption split to the processes and equipments could have been calculated by EINSTEN and the results are well comparable to the present state of the company. For the economic aspects some further calculations will be necessary as the funding rate and the final investment costs are based on first estimations. The report has been sent to the company and the results have been already discussed. The heat exchanger network will probably be installed as the investment costs are rather low. The installation of the flat plate collectors will be proven by the company in accordance with the auditor.